

TTL
LSI

TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275 4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS 7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

BULLETIN NO. DL-S 7612121, OCTOBER 1976

- 'S274 Provides 8-Bit Product in Typically 45 ns
- 'S274 Can Provide Sub-Multiple Products for n-Bit-by-n-Bit Binary Numbers
- 'LS275 and 'S275 Accept 7 Bit-Slice Inputs and 2 Carry Inputs for Reduction to 4 Lines in Typically 45 ns
- These High-Complexity Functions Can Reduce Package Count by Nearly 50% in Most Parallel Multiplier Designs
- When SN74S274 is Combined With SN74H183 (or SN74LS183) and Schottky Look-Ahead Adders, Multiplication Times are Typically:

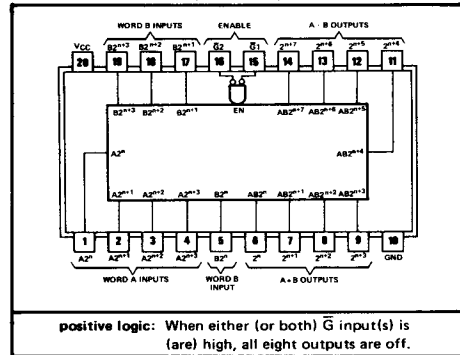
16-Bit Product in 75 ns (79 ns)
32-Bit Product in 116 ns (132 ns)

description

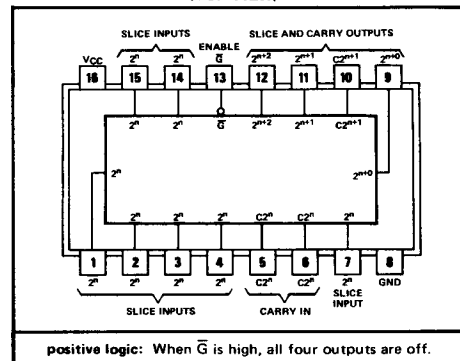
These high-complexity Schottky-clamped TTL circuits are designed specifically to reduce the delay time required to perform high-speed parallel binary multiplication and significantly reduce package count. The 'S274 is a basic 4-bit-by-4-bit parallel multiplier in a single package, and as such, no additional components are required to obtain an 8-bit product. For word lengths longer than 4 bits, a number of 'S274 multipliers can be combined to generate sub-multiple partial products. These partial products can then be combined in Wallace trees to obtain the final product. See Typical Application Data.

The 'LS275 and 'S275 expandable bit-slice Wallace trees have been designed to accept up to seven bit-slice inputs and two carry inputs from previous slices for reduction to four lines.

SN54S274 . . . J PACKAGE
SN74S274 . . . J OR N PACKAGE
(TOP VIEW)



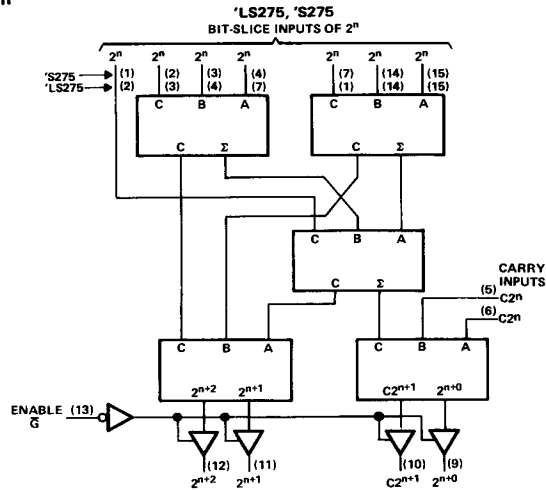
SN54LS275, SN54S275 . . . J PACKAGE
SN74LS275, SN74S275 . . . J OR N PACKAGE
(TOP VIEW)



7

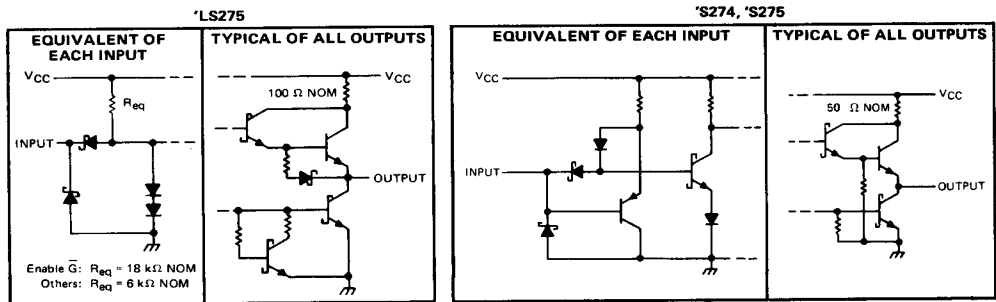
TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275 4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS 7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

functional block diagram



NOTE: When one of the C^{2^n} carry inputs is not used, it must be grounded. If neither C^{2^n} carry input is used, both C^{2^n} inputs are grounded and the $C^{2^{n+1}}$ output is normally left open.

schematics of inputs and outputs



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage: 'LS275	7 V
'S274, 'S275	5.5 V
Off-state output voltage: 'LS275	7 V
'S274, 'S275	5.5 V
Operating free-air temperature range: SN54LS, SN54S Circuits	-55°C to 125°C
SN74LS, SN74S Circuits	0°C to 70°C
Storage temperature range	-65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

TYPES SN54LS275, SN74LS275

7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

REVISED AUGUST 1977

recommended operating conditions

	SN54LS275			SN74LS275			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-1			-2.6	mA
Low-level output current, I_{OL}			12			24	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	SN54LS275			SN74LS275			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage		2			2			V
V_{IL}	Low-level input voltage		0.7			0.8			V
V_{IK}	Input clamp voltage	$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$	-1.5			-1.5			V
V_{OH}	High-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = V_{IL\text{max}}, I_{OH} = \text{MAX}$	2.4	3.2		2.4	3.1		V
V_{OL}	Low-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = V_{IL\text{max}}$	$I_{OL} = 12 \text{ mA}$		0.25	0.4	$I_{OL} = 24 \text{ mA}$		V
I_{OZH}	Off-state output current, high-level voltage applied	$V_{CC} = \text{MAX}, V_{IH} = 2 \text{ V}, V_O = 2.7 \text{ V}$	20			20			µA
I_{OZL}	Off-state output current, low-level voltage applied	$V_{CC} = \text{MAX}, V_{IH} = 2 \text{ V}, V_O = 0.4 \text{ V}$	-20			-20			µA
I_I	Input current at maximum input voltage	Enable \bar{G}	0.1			0.1			mA
		All others	0.3			0.3			
I_{IH}	High-level input current	Enable \bar{G}	20			20			µA
		All others	60			60			
I_{IL}	Low-level input current	Enable \bar{G}	-0.4			-0.4			mA
		All others	-1.2			-1.2			
I_{OS}	Short-circuit output current§	$V_{CC} = \text{MAX}$	-30	-130	-30	-130		mA	
I_{CC}	Supply current	$V_{CC} = \text{MAX}$	25 40		25 40			mA	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at $V_{CC} = 5 \text{ V}, T_A = 25^\circ \text{C}$.

§ Not more than one output should be shorted at a time and duration of the short-circuit should not exceed one second.

switching characteristics, $V_{CC} = 5 \text{ V}, T_A = 25^\circ \text{C}$

PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	Any Slice or Carry	Any	$C_L = 45 \text{ pF}, R_L = 667 \Omega,$	35	62		ns
t_{PHL}			See Note 2	42	66		
t_{PZH}	Enable \bar{G}	Any	$C_L = 45 \text{ pF}, R_L = 667 \Omega,$	8	23		ns
t_{PZL}			See Note 2	13	23		
t_{PHZ}			$C_L = 5 \text{ pF}, R_L = 667 \Omega,$	10	15		ns
t_{PLZ}			See Note 2	10	15		

¶ t_{PLH} ≡ Propagation delay time, low-to-high-level output

t_{PHL} ≡ Propagation delay time, high-to-low-level output

t_{PZH} ≡ Output enable time to high level

t_{PZL} ≡ Output enable time to low level

t_{PHZ} ≡ Output disable time from high level

t_{PLZ} ≡ Output disable time from low level

NOTE 2: Load circuit and voltage waveforms are shown on page 3-11.

TYPES SN54S274, SN54S275, SN74S274, SN74S275

4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS

7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

recommended operating conditions

	SN54S274 SN54S275			SN74S274 SN74S275			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-2			-6.5	mA
Low-level output current, I_{OL}			12			12	mA
Operating free-air temperature, T_A	-55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	SN54S274 SN54S275			SN74S274 SN74S275			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH} High-level input voltage		2			2			V
V_{IL} Low-level input voltage		0.8			0.8			V
V_{IK} Input clamp voltage	$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$	-1.2			-1.2			V
V_{OH} High-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = \text{MAX}$	2.4	3.4		2.4	3.2		V
V_{OL} Low-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OL} = 12 \text{ mA}$			0.5			0.5	V
I_{OZH} Off-state output current, high-level voltage applied	$V_{CC} = \text{MAX}, V_{IH} = 2 \text{ V}, V_O = 2.4 \text{ V}$			50			50	µA
I_{OZL} Off-state output current, low-level voltage applied	$V_{CC} = \text{MAX}, V_{IH} = 2 \text{ V}, V_O = 0.5 \text{ V}$			-50			-50	µA
I_I Input current at maximum input voltage	$V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$			1			1	mA
I_{IH} High-level input current	$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$			25			25	µA
I_{IL} Low-level input current	$V_{CC} = \text{MAX}, V_I = 0.5 \text{ V}$			-0.25			-0.25	mA
I_{OS} Short-circuit output current§	$V_{CC} = \text{MAX}$	-30		-100	-30		-100	mA
I_{CC} Supply current	$V_{CC} = \text{MAX}$		105	155		105	155	mA

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	SN54S274 SN54S275			SN74S274 SN74S275			UNIT
				MIN	TYP‡	MAX	MIN	TYP‡	MAX	
t_{PHL}	Any A or B ('S274), or Any Slice or Carry ('S275)	Any	$C_L = 30 \text{ pF}, R_L = 400 \Omega,$ See Note 3	50	95		50	70	ns	
t_{PLH}				50	95		50	70		
t_{PZH}	Any Enable	Any	$C_L = 5 \text{ pF}, R_L = 400 \Omega,$ See Note 3	15	45		15	30	ns	
t_{PZL}				15	45		15	30		
t_{PHZ}				10	40		10	25	ns	
t_{PLZ}				10	40		10	25		

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$.

§ Not more than one output should be shorted at a time and duration of the short-circuit should not exceed one second.

¶ t_{PLH} ≡ Propagation delay time, low-to-high-level output

t_{PHL} ≡ Propagation delay time, high-to-low-level output

t_{PZH} ≡ Output enable time to high level

t_{PZL} ≡ Output enable time to low level

t_{PHZ} ≡ Output disable time from high level

t_{PLZ} ≡ Output disable time from low level

NOTE 3: Load circuit and voltage waveforms are shown on page 3-10.

TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275 4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS 7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

TYPICAL APPLICATION DATA

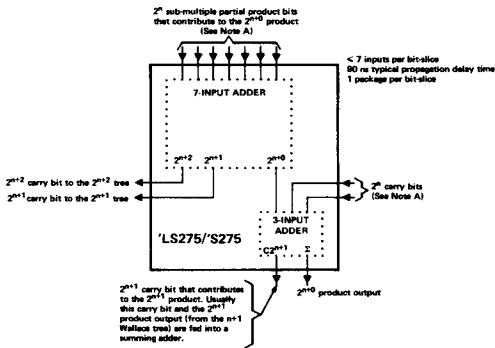


FIGURE 1—BASIC BIT-SLICE WALLACE TREE

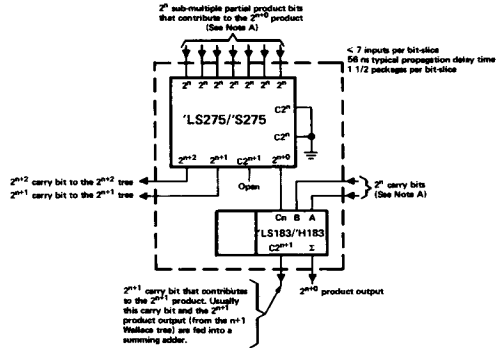


FIGURE 2—HIGH-SPEED BIT-SLICE WALLACE TREE

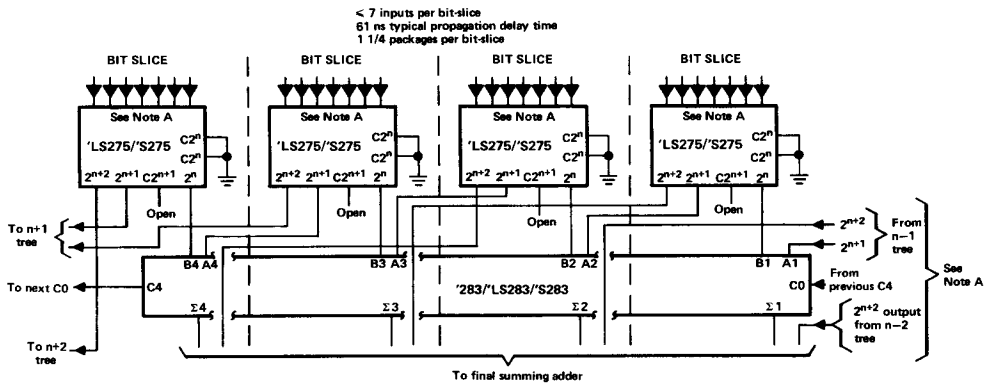
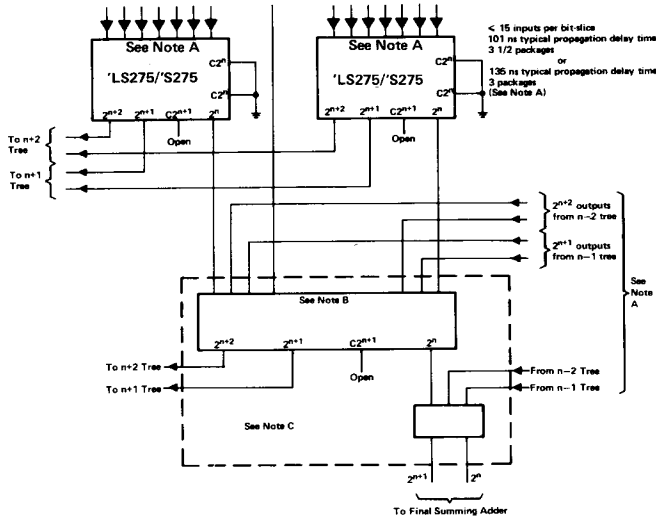


FIGURE 3—MODERATE-SPEED BIT-SLICE WALLACE TREE

NOTE A: All unused inputs must be grounded.

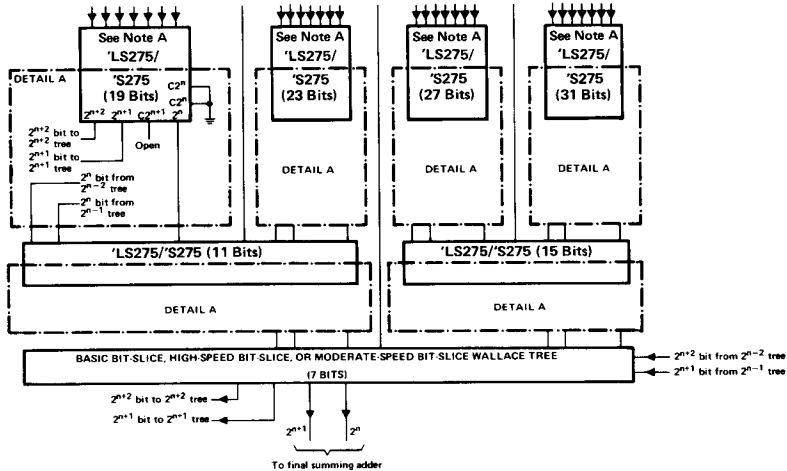
TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275 4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS 7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

TYPICAL APPLICATION DATA



- NOTES: A. Ground unused inputs.
 B. These outputs from preceding trees may go to any of the inputs of the 'LS275/S275'.
 C. The circuit within the dotted lines may be either the basic bit-slice Wallace tree or the high-speed Wallace tree. In the latter case both carry inputs of the 'LS275/S275 must be grounded.

FIGURE 4—15-BIT-SLICE WALLACE TREE FOR 32-BIT X 32-BIT MULTIPLIER



- NOTES: A. Ground unused inputs.
 B. The number of bits in parentheses is the maximum number of bits this tree can combine if the remaining 'LS275/S275 (all having a higher number in the parentheses) were not connected.

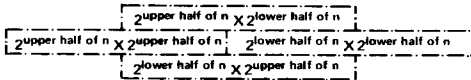
FIGURE 5—7-TO-31-BIT-SLICE WALLACE TREE FOR UP TO 64-BIT X 64-BIT MULTIPLIERS

TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275

4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS

7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

TYPICAL APPLICATION DATA



NOTE A: The left-hand half of each rectangle is the portion of word one used to obtain the product shown within the rectangle. Similarly, the right-hand half of each rectangle is the portion of word two used.

FIGURE 6—UNIVERSAL METHOD OF ADDING $\frac{n}{2}$ -BIT PRODUCTS TO OBTAIN AN n-BIT PRODUCT

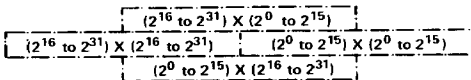


FIGURE 7—METHOD OF ADDING 32-BIT PRODUCTS TO OBTAIN A 64-BIT PRODUCT

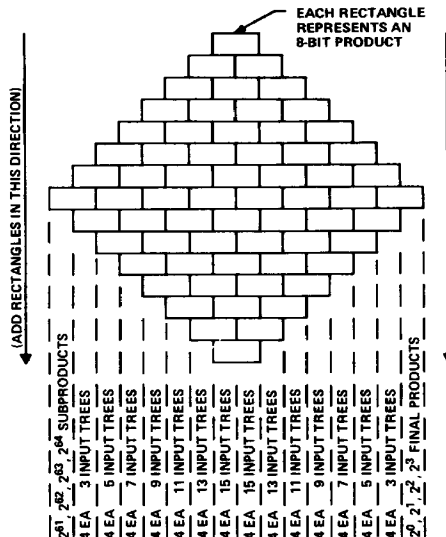
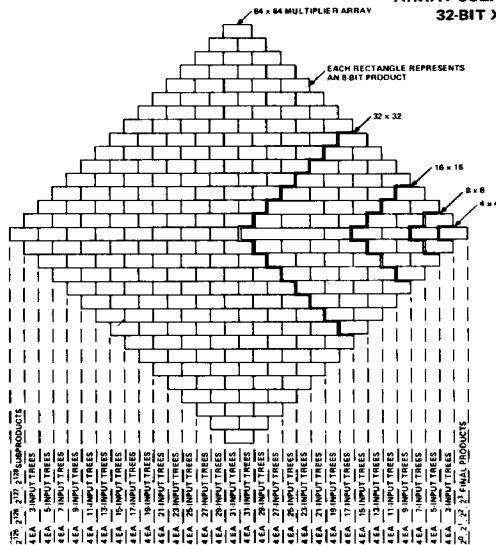


FIGURE 8—FINAL PRODUCTS AND ARRAY SUBPRODUCT ADDITIONS FOR 32-BIT X 32-BIT MULTIPLIER

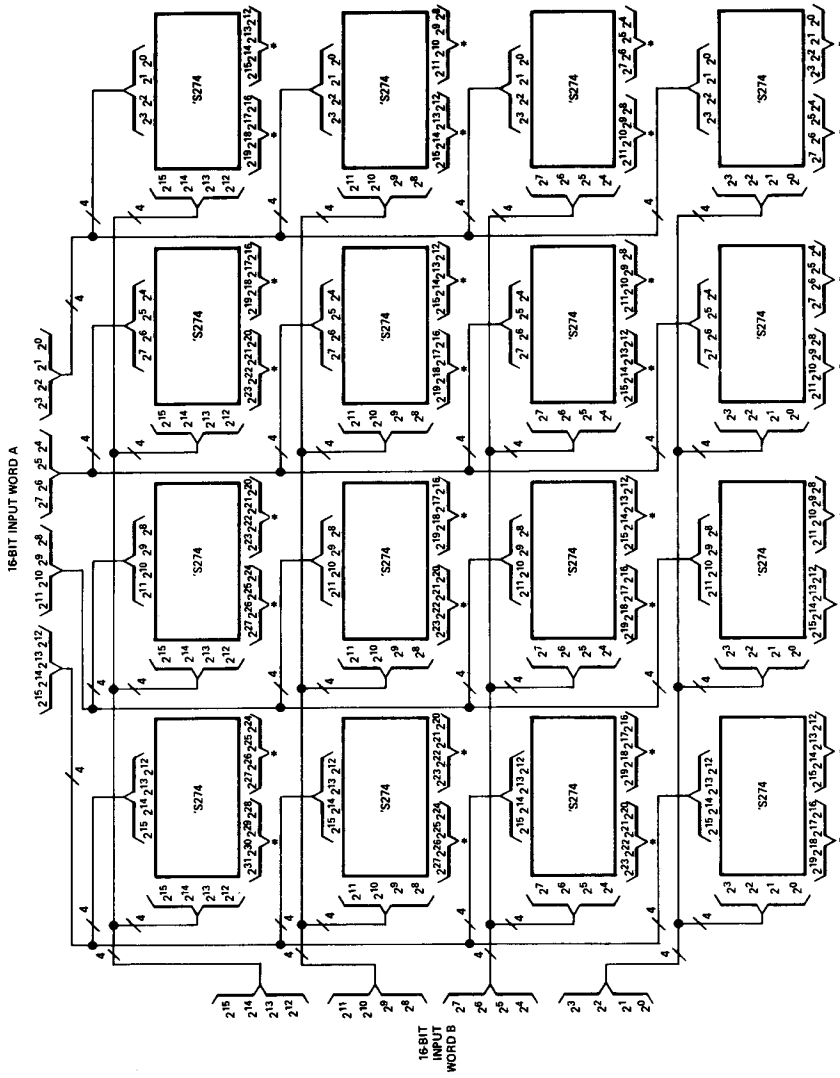


NOTE A: See Note B of Figure 6 for designing trees with any number of inputs up to 31.
 FIGURE 9—ARRAY ARRANGEMENT FOR VARIOUS MULTIPLIERS INCLUDING ARRAY SUBPRODUCT ADDITIONS FOR 64-BIT X 64-BIT MULTIPLIER

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TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275
4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS
7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

TYPICAL APPLICATION DATA



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* This 4-bit binary number is a partial product. See Figure 11, Sheets 2 and 3 for diagram of summation process.

FIGURE 10-16-BIT X 16-BIT MULTIPLIER (SHEET 1 OF 3-OUTPUT CONNECTIONS)

TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275
4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS
7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

TYPICAL APPLICATION DATA

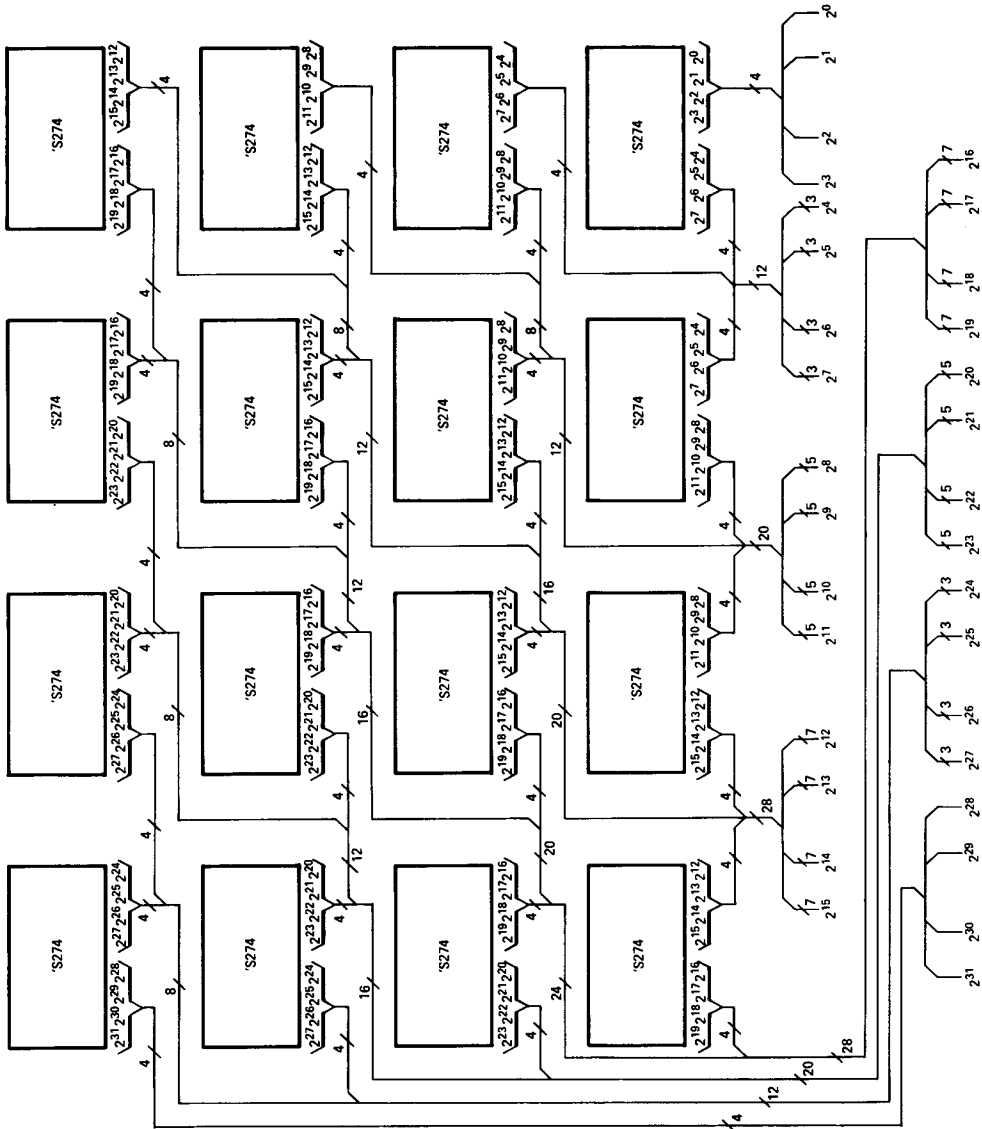
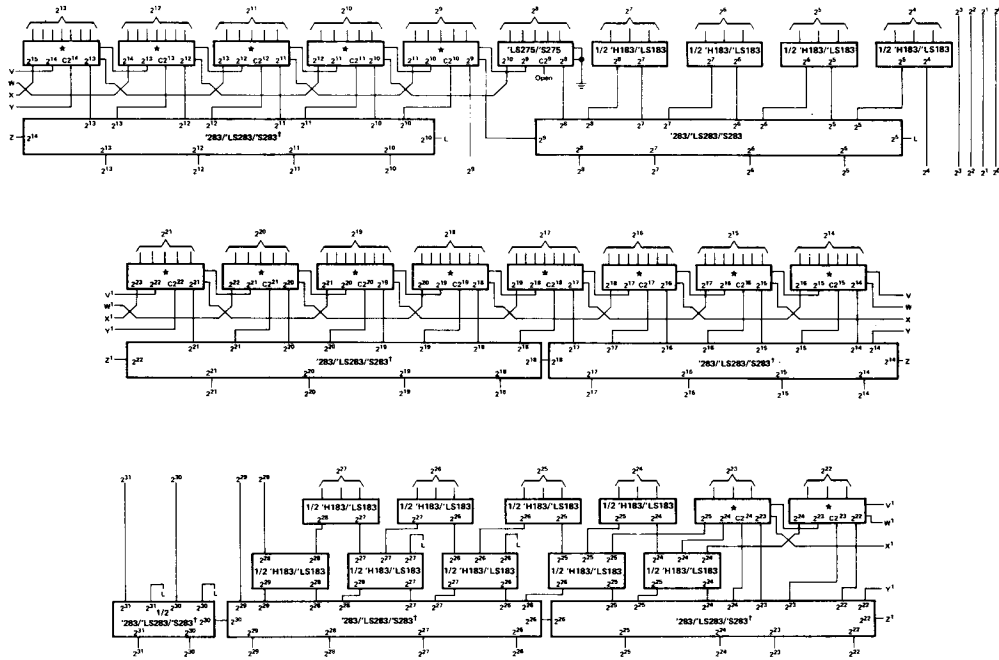


FIGURE 10-16-BIT X 16-BIT MULTIPLIER (SHEET 2 OF 3-OUTPUT CONNECTIONS)

TYPES SN54LS275, SN54S274, SN54S275, SN74LS275, SN74S274, SN74S275 4-BIT-BY-4-BIT BINARY MULTIPLIER WITH 3-STATE OUTPUTS 7-BIT-SLICE WALLACE TREES WITH 3-STATE OUTPUTS

TYPICAL APPLICATION DATA



*Each starred block may be either a basic bit-slice Wallace tree ('LS275 or 'S275 only) or a high-speed bit-slice Wallace tree ('LS275 plus 1/2 'LS183 or 'S275 plus 1/2 'H183). In either case the function of the terminal is the same as the similarly located terminal of the basic bit-slice (Figure 1) or high-speed bit-slice Wallace tree (Figure 2). Also for either tree, when only five inputs of the seven-input adder of the 'LS275/'S275 are used, the remaining two inputs must be grounded. When the high-speed adder is used, the C²⁰ inputs of the 'LS275/'S275 must be grounded.

†For improved performance SN74LS181/SN74S181 ALUs with SN74S182 look-ahead generators can be substituted for the SN74283/SN74LS283/SN74S283 adders. Typically, the multiplication time will be reduced by 18 to 32 nanoseconds.

FIGURE 10—16-BIT X 16-BIT MULTIPLIER
(SHEET 3 OF 3—SUMMING PARTIAL PRODUCTS)